Ohio Statewide Traffic Model
Executive Summary and Potential Uses

Introduction

The following paper is intended to provided ODOT management with a brief overview of the Ohio Statewide Traffic Model (more formally: The Ohio Statewide Integrated Economic, Land Use and Travel Demand Forecasting Model, but henceforth referred to as “the model”). The paper will briefly describe why the model was developed and how it works but will focus on inputs, outputs and their potential usefulness to the decision making process.

Historical Context

Before describing the model and its uses, it may be useful to address the history and motivations that have lead to the development of this model. The model is being developed by the Modeling & Forecasting Section of the Office of Technical Services. This section’s core business is the provision of traffic forecasts. In this role, the section provides certified design traffic for ODOT projects as well as traffic forecasts for planning studies (including bypass, corridor and transit route planning), system-wide congestion analysis and air quality conformity analysis.

Travel Demand Forecasting (TDF) Models have been the primary tool for traffic forecasters since their initial development in Metropolitan Planning Organization (MPO) areas in the 1960’s. This early development was in response to Federal mandates related to the massive upsurge in Federal highway funding at that time. The early model consisted of the “four step process” of trip generation, trip distribution, mode choice and traffic assignment. These models used aggregate statistical relationships derived from household travel surveys to allow one to create forecasted origin-destination flows which could then be assigned to a computerized network of the highway system. They only modeled short distance urban passenger transport. At the time little effort was made across the nation at trying to translate these principals into statewide or national travel models due in part to computer limitations but also the relative lack of knowledge about long distance and freight/business travel which is more important at this scale. Ohio has 17 MPOs; each has a TDF model, which ODOT, in one way or another, helps to maintain. The computer highway networks for these areas are shown in Figure 1.

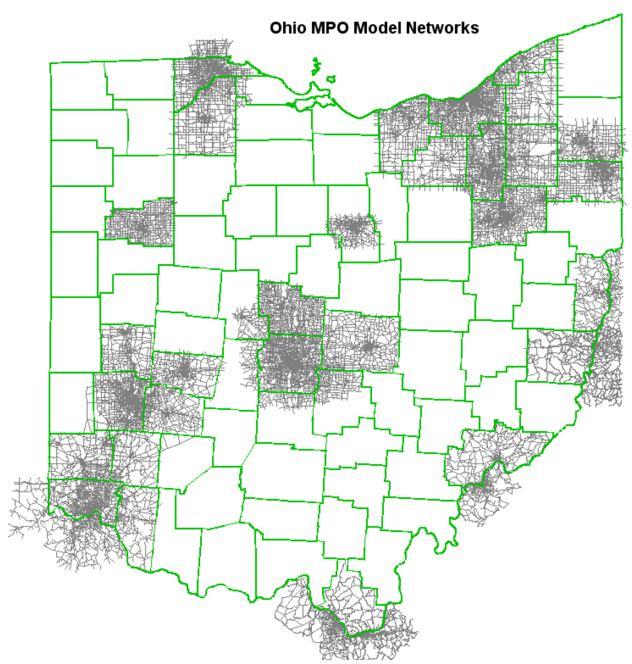

Figure 1

The economic climate and focus on completion of the already planned for interstate system by the Federal Government in the 1970's and 1980's meant that the types of large scale transportation planning for which TDF models were well suited became less common. As a result many of the TDF models fell from use. However, the Clean Air Act Amendments of 1990 and the ISTEA transportation bill in 1992 created a variety of new requirements which resulted in the reemergence of TDF models as important tools for transportation agencies. The increased Federal interest meant increased funding for research which produced improved techniques throughout the 1990's. This coupled with vastly better computer hardware meant that for the first time, useful statewide TDF models became practical.

The statewide TDF model was thus begun by the ODOT Modeling and Forecasting Section in the late 1990's because it had always been recognized that our core business of providing traffic forecasts would be better served by the presence of such a model. A statewide model would provide the ability to analyze large multi-region corridors, to conduct consistent system-wide analysis and to provide a traffic forecasting tool in the rural areas of the state not covered by the urban MPO models. While a bottom up approach was used to initiate this effort, it was immediately recognized that any such model should be able to provide the information decision makers need. Therefore a needs study was first conducted to assess what type of statewide traffic model should be developed.

ODOT Needs Study

A needs study was conducted in late 1998 and early 1999 to assess what information the transportation planning stakeholders and decision makers needed. The study had 2 major components. The first was a series of 3 workshops conducted with ODOT District personnel, ODOT central office personnel and MPOs and RDCs (Regional Development Commissions). The second were personal interviews with ODOT senior management. This study produced the following three priority issues that the model needed to address:

- reducing / minimizing / avoiding roadway congestion and delay;
- sustaining and improving the state economy;
- freight planning, particularly with regard to the management of truck traffic and the potential for shifting it to other routes and modes.

In addition, the following secondary factors were identified which were to be addressed to the extent possible:

- supporting multi-modal/inter-modal options for travel, passenger and freight;
- improving conditions for non-auto (and non-single-occupant auto) mode services;
- maintaining / improving safety;
- mitigating the impacts of new development and related access management;
- maintaining / improving air quality;
- reducing conflicts between modes.

The model design was governed by the principal of creating its basic structure to address the three priority issues while addressing the secondary issues as much as possible with this structure. The key thing that the needs study demonstrated was that while any TDF model structure could address the issue of congestion and delay, the need to explicitly address the state's economy and freight flows would require a much more advanced formulation than originally envisioned. Because of this, ODOT embarked upon a model design employing leading edge techniques to integrate economics, land development and transport models into a single consistent modeling system.

Model Structure

The model being developed is an integrated economic, land use and travel demand forecasting model. Figure 2 shows the overall schematic of this model. The major areas are listed below:

Economic Activity

- Economic layer added above the traditional travel models allows a whole range of additional economic analysis/outputs
- Model steps through time with conditions from the previous time interval impacting later land development, industrial production, residence location and travel decisions
- Distribution of economic activities & flows by industry sector and commodity to analysis zones gives the fine geographic resolution needed to support travel modeling

Land Development

- Economic models interact with a land development model which incorporates representation of land supply, development types, zoning, water & sewer service, flood plains, steep slopes, other protected land uses and land prices

Personal Travel

- Short Distance weekday travel behavior of persons for all purposes: work & school, shopping, recreation and other
- Long Distance weekday travel behavior of persons for business, entire household (typically social/recreational) or other individual travel
- Microsimulation of individuals and the segregation of occasional long distance vs. day to day short distance travel allows detailed market segmentation and analysis of how policies impact these travel markets differently
- Explicit treatment of travel by out of state visitors

Commercial Travel

- Incorporates long-haul commodity shipment, localized goods delivery, service provision & work-related tours
- Long-haul shipment related directly to commodity flows
- Micro-simulation of daily commercial tours for each employee (a first at this scale)
- Allows detailed analysis of commercial vehicle traffic including commodities carried or purpose of travel

Ohio Integrated Land Use/Economic/Transport Model

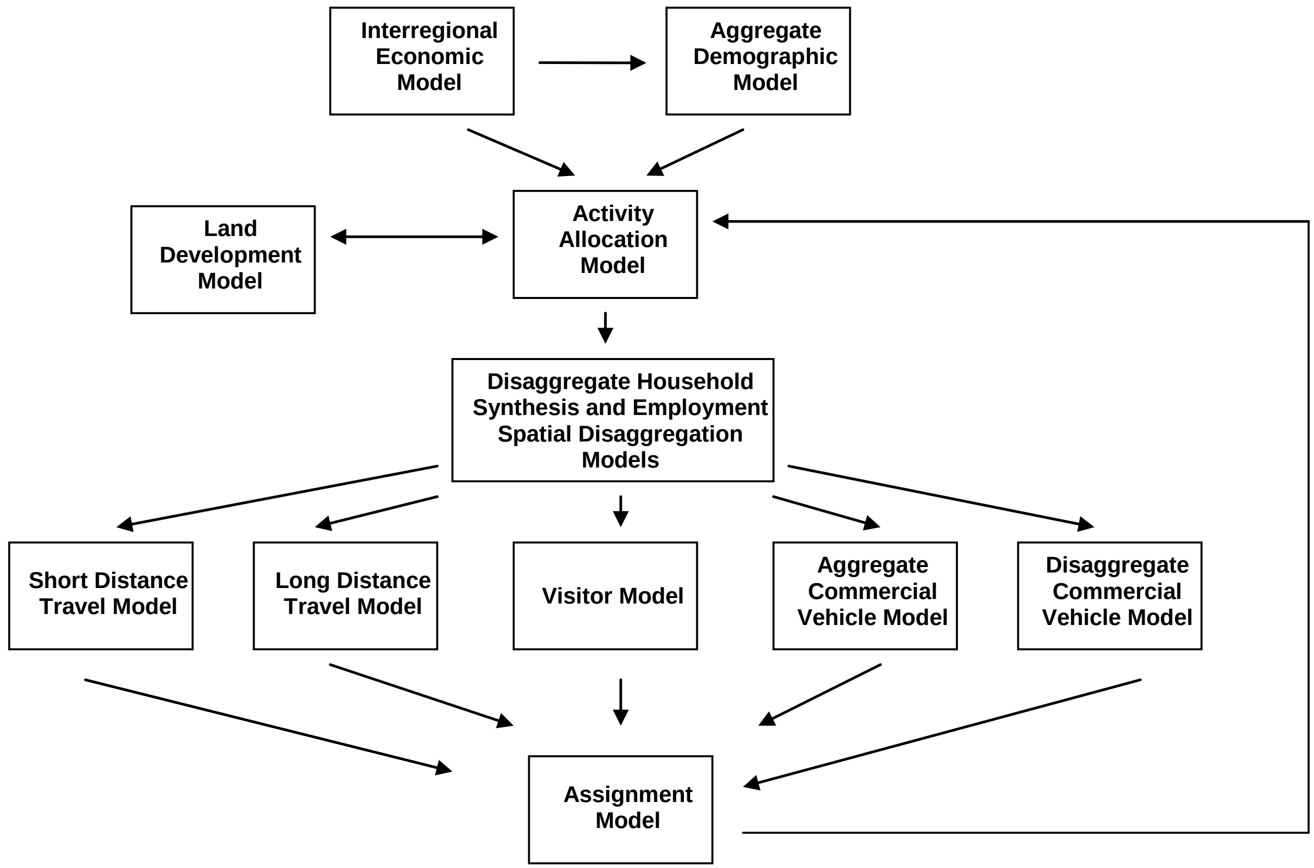

Figure 2

Inputs

The model uses a vast array of input data. Much of this data may be of interest to policy makers in and of itself due to the insights it can provide about conditions in various locations. Appendix A contains a presentation displaying many of these inputs. Some of the most important include:

- Computerized highway, rail and transit route networks containing attributes such as lanes, widths, speed limits, facility class, intersection control, service frequencies etc.
- Employment by employer
- Population and demographic data from the US Census
- Water and sewer service coverage
- Severe slope areas
- Flood plain areas
- School district quality
- Existing trade relationships by industrial sector, by commodity by region
- Household travel surveys
- Establishment (business) travel surveys
- Roadside Intercept surveys
- Existing land uses
- Zoning and land value by parcel (not available statewide)

Outputs & Potential Uses

The primary output of the model is the same as any TDF model, namely segment specific volumes of persons and vehicles. In the case of highway volumes these are further stratified by vehicle class (corresponding to the weight classifications used by the Ohio Turnpike) and time of day. Combining this output with input network characteristics such as travel speeds, distances and intersection controls as well as supplemental data on crash rates, pollution emission rates, value of time, vehicle operating costs et cetera, allows one to develop the whole range of user cost/benefit information typical to transportation analysis. Appendix A contains examples of many of these including:

- Vehicle Miles Traveled
- Vehicle Hours Traveled
- Crashes
- Level of Service
- Delay
- Growth Rates
- Air pollution emissions
- Volume to Capacity Ratios
- Duration, extent and location of congestion
- Vehicle Operating Costs
- Value of time cost of travel time for both persons and transported goods
- Origin-Destination Flows

ODOT Modeling & Forecasting section already has in place 2 model post-processors, the congestion management and air quality analysis process and the user benefits process which automatically create all these measures and more from TDF model results. These measures will be used in existing ODOT processes such as the development of design year traffic for projects, demonstration of conformity with air quality regulations, congestion management system reporting and individual planning studies.

Beyond these traditional travel model outputs, the nature of the Ohio Statewide Traffic Model provides 3 new categories of output.

The travel models themselves do not use the traditional aggregate statistical approaches but rather micro-simulate each individual traveler. The implication is that detailed analysis of the road users is possible, allowing for example:

- Environmental Justice analysis of disadvantaged populations
- Segregation of road users by travel purpose and residence status allowing evaluation of pricing strategies and whom they will impact

The integrated econometric model produces at its heart, dollar flows worth of commodities (including labor) between industrial sectors between geographic regions. These dollar flows are then converted to various other quantities such as persons, tons, trucks and trains flowing between these areas. This output can be used for many purposes such as:

- Providing a consistent method for evaluating economic impact of projects and policies (however, see the caveats section)
- Provide a forecast of economic and travel conditions (localized and global) consistent with infrastructure development (including non-transportation infrastructure such as water service), policies, national economic trends and Ohio Department of Development population control totals.
- Allows industrial and labor sectors to be studied by geographic area and their interaction with other areas including shifts in employment caused by projects and policies

The land development model produces land categories by traffic analysis. This information can be used to study (for example):

- Impact of policies on agricultural acreage for farmland preservation analysis
- Development of new commercial/industrial land around proposed interchanges
- Urban sprawl analysis comparing amounts of developed land with and without proposed projects or policies

Caveats

If the Ohio Statewide Traffic Forecasting Model seems impressive, it is. While more than half the states have now developed or are developing statewide traffic models, none to date has the sophistication of Ohio's model (though it is becoming clear that this will become the prototype for what future statewide models will be). However, it should be remembered, it is a model. Despite 10 years of effort, collection and assembly of huge amounts of data and the input of numerous PhD scientists and engineers, it still has limitations. A model implies that certain simplifying assumptions are made in an attempt to replicate reality. Listed below are a few limitations of the model.

It is huge and requires several days to run on a very large computer to produce a complete 30 year forecast of economic/travel conditions. The main implication to this is that the model can only be fully run a few times per year. The intent is to create at least 2 base runs per year, a no build and a build involving ODOT's capacity expansion program. A few additional project specific runs for certain "mega projects" would also be made. For the majority of ODOT's needed traffic forecasting, the results of the 2 base runs would be used or static Origin-Destination demand flows extracted from those runs would be reassigned to demonstrate route diversion on lesser projects.

Some of the data used in the model is confidential. Taken with the previous limitation regarding the necessary computer hardware to run the model, the implication of this is that ODOT won't be handing the model out to consultants, it will either be run in house by ODOT staff or consultant staff will be able to come on site to make runs in some cases.

The model works on averages and from the known initial conditions. From these it will pivot in a somewhat smooth way based on the economic and transport conditions. The implication being that it will not predict where a new Toyota plant or Walmart might locate. However, the model does have an over-ride file allowing ODOT to specify the location where large developments like this are proposed.

The econometric model is driven by national economic indicators. These indicators can change the relationship between Ohio's economy and the rest of the country. However, currently no policies or projects undertaken by Ohio will make Ohio seem particularly better than other regions of the country. This is partly because there is no way of knowing what policies and projects those areas might embark upon to improve their own competitiveness. Generally, policies and projects in Ohio will simply shift things around in Ohio (though a small amount of shifting into Ohio from the adjacent states can occur). In the future, some limited capability in this regard may be added; however, the sensitivities would be highly speculative.

APPENDIX A

Sample Presentation Data

DOUBLE CLICK TO SEE PRESENTATION